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(54) Title: ABRASIVE BODY


(57) Abstract

An abrasive body which comprises an abrasive compact bonded to a support along an interface, the abrasive compact presenting a working surface and a cutting edge or point on that surface, is provided. The abrasive compact in the abrasive body is characterised by the particle size at the working surface being finer than that at the interface and the particle size of the compact changing from the working surface to the interface in a continuous manner and with the substantial absence of any boundary between particle sizes. There is thus a continuous grading of particle size from the working surface to the interface.

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# ABRASIVE BODY

## BACKGROUND OF THE INVENTION

This invention relates to an abrasive body containing abrasive compact.

Abrasive compacts are well known in the art and are used extensively for a variety of cutting, grinding, dressing, drilling and other applications. Abrasive compacts comprise a mass of abrasive particles bonded into a polycrystalline hard conglomerate. The abrasive particles are generally diamond or cubic boron nitride. Diamond abrasive compacts are also known as PCD and cubic boron nitride compacts are also known as PCBN.

Abrasive compacts have been produced in which there are at least two distinct zones or sections – the one being produced using coarse particles and the other fine particles. In these prior art compacts, there are clearly defined regions or zones containing the different sized particles and clearly defined boundaries between the regions and zones. Examples of compacts of this nature are described in US 4,311,490 and ZA 80/1829. A problem with abrasive compacts containing distinct zones or sections is that stresses are created in the compact layer leading to delamination and hence failure in use.

## SUMMARY OF THE INVENTION

According to the present invention, an abrasive body comprises an abrasive compact bonded to a support along an interface, the abrasive compact presenting a working surface and a cutting edge or point on that surface, the particle size of the abrasive compact at the working surface being finer than that at the interface, and the particle size of the compact changing from the working surface to the interface in a continuous manner and with the substantial absence of any boundary between particle sizes. There is thus a continuous grading of particle size from the working surface to the interface.

The range of particle size from the working surface to the interface will vary according to the nature of the abrasive operation to which the abrasive body is to be put. A typical particle size range will be 4 to 80 microns. In this case, the 4 micron particles will dominate at the working surface and the 80 micron particles will dominate at the interface. Between these two regions there will be a continuous change of particle size from 4 through to 80 with the substantial absence of any boundary between particle sizes. The absence of such boundaries has the advantage that any residual or sintering stresses which would have occurred between different diamond layers, as in the prior art compacts described above, are equally distributed over the entire compact layer and the mechanical properties of the abrasive body as a whole are improved.

The invention has particular application to abrasive bodies comprising diamond abrasive compacts or cubic boron nitride compacts.

The support will generally be a cemented carbide support. The cemented carbide may be any known in the art such as cemented tungsten carbide, cemented titanium carbide or cemented tantalum carbide.

According to another aspect of the invention, a method of producing an abrasive body as described above includes the steps of providing a mass of abrasive particles having a particle size range from fine to coarse, causing the particles in the mass to move producing a mass of particles which changes from fine to coarse particles in a continuous manner and with the substantial absence of any boundary between particle sizes, and subjecting the mass to elevated temperature and pressure conditions suitable to form an abrasive compact.

Abrasive particles come in various sizes. For example, there is a particle size defined as 40-80 microns. This means that the particles will range from 40 to 80 microns with the dominant amount of the particles being about 75 microns. Similarly, for a fine grade particle of size 5 to 15 microns, the particles will vary from 5 to 15 microns with the dominant amount of particles being about 10 to 12 microns. In the method of the invention, a mixture of particles of these two sizes or grades may be provided and the particles then caused to move relative to each other creating a continuous graded form in which the fine particles are separated from the coarsest particles by a region which has substantially no boundary between particle sizes.

The mass of abrasive particles may be suspended in a liquid and the particles caused to move to produce the particle mass of desired form due to the difference in particle size, i.e. the finer particles will tend to rise and the coarser particles tend to sink in the liquid. The liquid may contain a binder capable of setting to a coherent form. In this form of the invention, the liquid, once the particle mass of the desired form has been produced, is removed to allow the binder to set into a coherent form. The liquid will typically be water. Examples of suitable binders are cellulose ethers, acrylic resins, polyvinyl alcohols and butyral. The liquid may also contain a plasticiser.

The desired form of the particle mass may be produced by bringing a layer of fine abrasive particles into contact with a layer of coarse abrasive particles to produce a layered mass, and subjecting the layered mass to agitation to cause relative movement of the particles between the layers. The layer of fine particles will generally be placed on the layer of coarse particles which itself will typically be placed on a surface of the support.

It is also possible to produce the particle mass of the desired form by providing a mixture of fine and coarse particles and subjecting the mixture to agitation to cause relative movement between the particles to produce the particle mass of the desired form.

The conditions of elevated temperature and pressure necessary to produce an abrasive compact from the abrasive particle mass are well known and well established in the art. The elevated temperature will generally be in the range 1300 to 1600°C and the elevated pressure will generally be in the range 4 to 7 GPa.

## BRIEF DESCRIPTION OF THE DRAWING

The drawing illustrates an electron microscope photograph of a PCD layer of the invention.

## DESCRIPTION OF EMBODIMENTS

In a first embodiment of the invention, three grades of micron diamond were provided – 30, 12 and 4. The weight ratios of the various grades was 1:1,5:2. In these grades, the 30, 12 and 4 micron sized particles, respectively, will dominate, but each grade also contain larger and smaller particles in various amounts.

Each grade of micron diamond was suspended in water, the suspension containing 40 weight percent micron diamond, and 60 weight percent water. The three suspensions were mixed and agitated continuously using a magnetic stirrer. An appropriate volume of an aqueous solution of polymer binder was added to the slurry. Examples of suitable binders are cellulose ethers, polyvinyl alcohols, acrylic resins or butyral. A water-soluble plasticizer may also be added to the slurry. Examples of suitable plasticizers are polyethylene glycols and phthalate compounds.

The inside surface of a flat glass dish of suitable diameter was covered with a release agent. The aqueous diamond slurry was transferred quantitatively into the glass dish. The glass dish with the slurry on it was placed in an ultrasonic bath, which was in operation, and left there for 15 minutes.

The dish was carefully removed and transferred to a drying oven set at about 60°C. When most of the water had evaporated, but with some moisture still being present, the thus produced casting was cut or punched into the required shape and size and carefully removed from the dish. The casting was then allowed to dry completely.

The casting was placed on a surface of a tungsten carbide substrate or support to form an unbonded assembly. The unbonded assembly was placed in a reaction capsule which itself was placed in the reaction zone of a conventional high temperature/high pressure apparatus. The contents of the reaction capsule were subjected to a temperature in the range 1300 to 1600°C and a pressure in the range 4 to 7 GPa. These conditions were maintained for a period of about 20 to 30 minutes.

Recovered from the reaction capsule using conventional techniques was a product comprising a diamond compact or PCD layer bonded to a cemented carbide substrate. This product was EDM cut and polished on edge to determine the degree of sintering of the PCD layer and the appearance thereof. Figure 1 illustrates an electron microscope photograph of the PCD layer. It will be noted from the photograph that there is a zone of the fine particles at 10 and a zone 12 of coarser particles and a zone 14 of the coarsest particles. The transition between the zones is continuous and essentially free of a boundary or interface. The cemented carbide substrate is bonded to the lower surface of zone 14.

In another embodiment of the invention, a cemented carbide substrate in disc form was provided. A recess was formed in the one flat surface of the disc. Placed in the recess was a layer of 30 micron grade diamond and on top of that a layer of 4 micron grade diamond. This formed an unbonded assembly which was then subjected to vigorous agitation. On agitation, particles from the fine layer moved into or dispersed into the coarse layer producing a diffuse interface or boundary between the two layers. The unbonded assembly was then subjected to elevated temperature and pressure conditions as described above, to produce a diamond compact or PCD of the diamond particles which was bonded to the cemented carbide. The sides of the disc are removed to expose a diamond cutting edge. The compact region with the coarsest particles was adjacent the compact/carbide interface and the region with the finest particles was at the cutting edge.

CLAIMS

1. An abrasive body comprising an abrasive compact bonded to a support along an interface, the abrasive compact presenting a working surface and a cutting edge or point on that surface, the particle size of the abrasive compact at the working surface being finer than that at the interface and particle size of the compact changing from the working surface to the interface in a continuous manner and with the substantial absence of any boundary between particle sizes.

2. An abrasive body according to claim 1 wherein the range of particle size from the working surface to the interface is from 4 to 80 microns.

3. An abrasive body according to claim 1 or claim 2 wherein the compact is a diamond abrasive compact.

4. An abrasive body according to any one of the preceding claims wherein the support is a cemented carbide support.

5. A method of producing an abrasive body according to any one of the preceding claims includes the steps of providing a mass of abrasive particles having a particle size range from fine to coarse, causing the particles in the mass to move producing a mass of particles which changes from fine to coarse particles in a continuous manner and with the substantial absence of any boundary between particle sizes, and subjecting the mass to elevated temperature and pressure conditions suitable to form an abrasive compact.

6. A method according to claim 5 wherein the mass of abrasive particles is suspended in a liquid and the particles caused to move due to difference in particle size, to produce a particle mass of the desired form.

7. A method according to claim 6 wherein the liquid contains a binder capable of setting to a coherent form and the liquid, once the particle mass of the desired form has been produced, is removed to allow the binder to set into a coherent form.

8. A method according to claim 7 wherein the binder is selected from cellulose ethers, acrylic resins and polyvinyl alcohols.

9. A method according to any one of claims 6 to 8 wherein the liquid contains a water-soluble plasticiser.

10. A method according to claim 9 wherein the plasticiser is selected from polyethylene glycols and phthalate compounds.

11. A method according to any one of claims 7 to 10 wherein the coherent form of the particle mass in the desired form is placed on a surface of a support such that the coarsest particles are adjacent to or on that surface.

12. A method according to claim 5 wherein a layer of fine abrasive particles is brought into contact with a layer of coarse abrasive particles to produce a layered mass and the layered mass is subjected to agitation to cause relative movement of the particles between the layers.

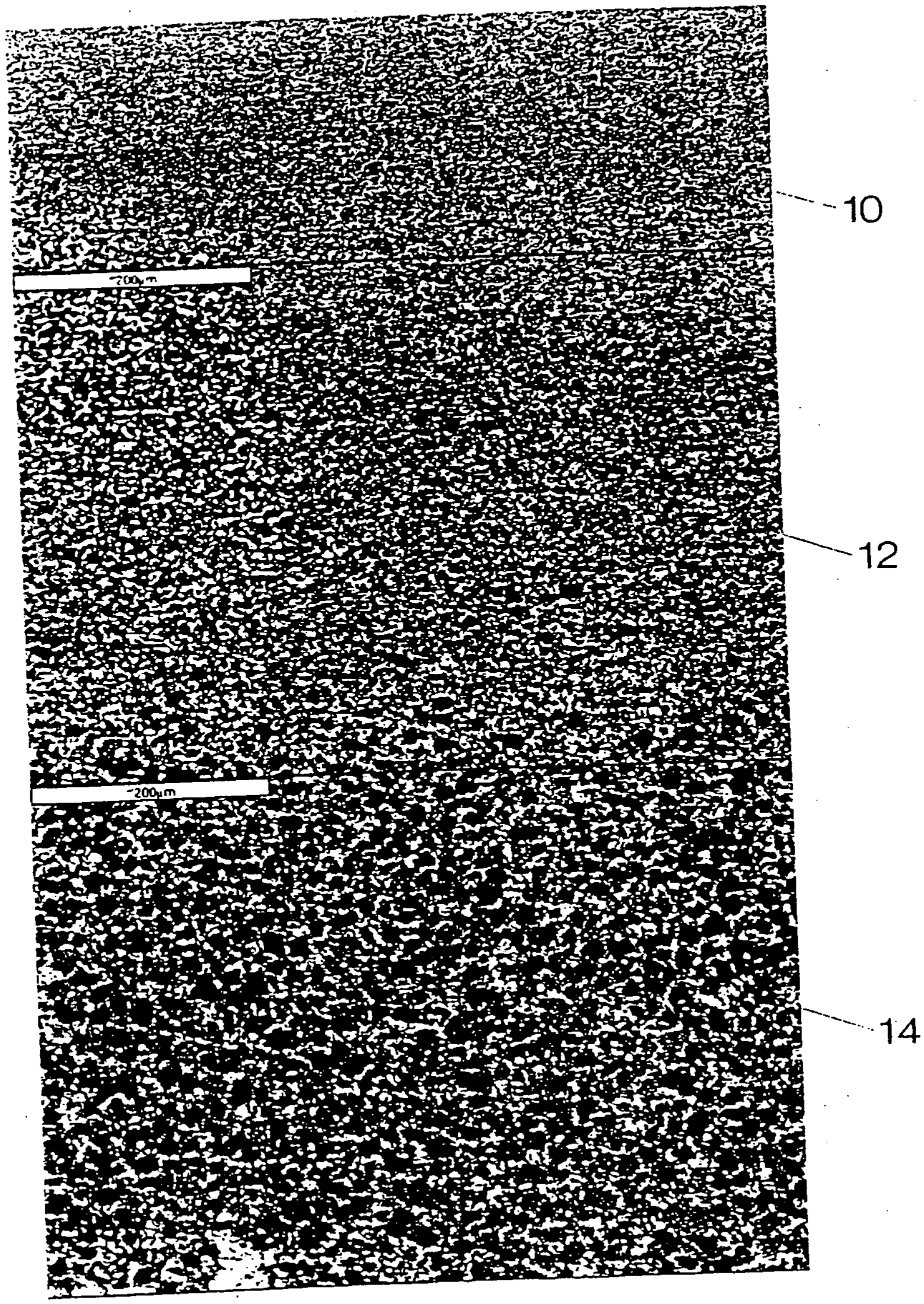
13. A method according to claim 12 wherein the layer of fine particles is placed on the layer of coarse particles.

14. A method according to claim 12 wherein the layer of coarse particles is placed on a surface of a support.

15. A method according to claim 5 wherein a mixture of fine and coarse particles is provided and the mixture is subjected to agitation to cause relative movement between the particles to produce the particle mass of the desired form.

16. An abrasive body according to claim 1 and substantially as herein described with reference to the accompanying drawing.

17. A method according to claim 5 substantially as herein described with reference to the accompanying drawing.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# INTERNATIONAL SEARCH REPORT

Inte. [illegible]nal Application No
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**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 7 B22F7/06

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B22F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category * | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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☐ Further documents are listed in the continuation of box C.

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Information on patent family members

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